

Remarks

Amendments to the Claims

Independent claim 1 has previously required the preparation of a mixture of a hydride and a hydroxide for release of hydrogen on demand for use in a hydrogen consuming application. Claim 1 is amended to state that the prepared mixture is placed in a hydrogen storage device, the hydrogen storage device being adapted for release of hydrogen from the prepared mixture and delivery of hydrogen to the hydrogen consuming application. Upon a demand for hydrogen on behalf of the hydrogen consuming application, hydrogen is released from the prepared and stored mixture by the claimed method. During a demand on behalf of the hydrogen consuming application, hydrogen is delivered from the prepared mixture in the hydrogen storage device to the hydrogen consuming application to leave an oxide as substantially the sole residue material in the hydrogen storage device.

Independent claim 67 has previously been presented in a format like that of independent claim 1. Claim 67 is now amended in the same manner as the amendments to claim 1.

Paragraphs 0002- 0004 of the specification (referring to the paragraph numbering in the published application 2005/0191234) describe how hydrogen and solid hydrogen storage hydrides may be stored in hydrogen storage devices to provide hydrogen as a fuel source, particularly for mobile applications (such as fuel cells). Such devices provide a chamber that houses the hydrogen storage material (0004) and may contain other features such as heat exchangers used in release of the hydrogen and/or in recharging of hydrogen in the storage material in the chambers of the storage device. U.S. patent 6,015,041 is identified as further disclosing exemplary hydrogen storage materials and a hydrogen storage device to which the prepared hydrogen storage materials are added.

Paragraph 0006 of the published application discloses that the subject invention provides an improved hydrogen storage composition for such a hydrogen storage device, and a method for forming such materials. Paragraphs 0039, 0041, 0056, 0104, and 0140 of the published application further disclose, for example, how the subject mixtures of hydrides and

hydroxides facilitate reduced energy requirements for the release of hydrogen from a prepared mixture in a hydrogen storage device on demand by an on-vehicle fuel cell, or the like.

No new matter is added to the claims or specification by the amendments to claims 1 and 67.

Independent claim 72 and its dependent claims have been canceled.

The Claim Rejections under 35 U.S.C. 102(b) and 35 U.S.C. 103(a)

Remaining claims 1, 3-5, 7, 8, 10-12, 14, 19-21, 26-29, 54-55, 57, 63, and 67-70 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Machin et al. (“Kinetics of the Reaction of Water Vapour with Crystalline Lithium Hydride”).

Remaining claims 15, 48, 49, 61, and 64-66 are rejected under 35 U.S.C. 103(a) as being unpatentable over Machin et al. (“Kinetics of the Reaction of Water Vapour with Crystalline Lithium Hydride”) in view of Amendola et al. (US 2004/0033194).

It is respectfully requested that each of these rejections be reconsidered and withdrawn in view of the following remarks and arguments.

The Claimed Invention

Independent claims 1 and 67 are method claims which require the preparation of a mixture of particles of a hydride and a hydroxide for release of hydrogen upon demand. The prepared mixture is placed in a hydrogen storage device adapted for the release of hydrogen from the prepared and stored mixture, and delivery of hydrogen to the hydrogen consuming application. Subsequent references in the claims to “the mixture” are references to “the prepared mixture”, placed in the hydrogen storage device.

Upon a demand for hydrogen from the stored mixture, water is reacted with a portion of the hydride particles, now in the hydrogen storage device, to produce heat to initiate reaction between a second portion of hydride particles and particles of the hydroxide. The proportions of hydride particles and hydroxide particles in the prepared and stored mixture (of each of claims 1 and 67) are such that the hydride reacts substantially completely with the water and hydroxide to form hydrogen for the hydrogen consuming application. The hydrogen leaves the storage device

for use in the hydrogen consuming device. As the prepared and stored mixture is thus consumed, substantially the only residue of the hydride and hydroxide is an oxide. At the completion of the demand for hydrogen and its delivery from the hydrogen storage device, the oxide remains as substantially the sole residual material in the hydrogen storage device.

Thus, the composition of the prepared and stored mixture is such that the hydride particles and hydroxide particles are substantially fully consumed in their release of hydrogen so that only an oxide of their cations remains. In accordance with the claimed method, a mixture of hydride particles and hydroxide particles are prepared in proportions that effectively produce hydrogen on demand and leave a residue of only an oxide of the starting materials. In accordance with a companion application to this application (now patented), the oxide may be processed back to one or both of the hydride or hydroxide starting materials. Further, in accordance with the claimed methods, when hydrogen is needed, a quantity of water is reacted with a portion of the hydride particles in the prepared and stored mixture to initiate further hydrogen-producing reaction between hydride particles and hydroxide particles. Certainly, the disclosure of the Machin et al publication neither anticipates nor makes obvious any of the method claims of this application.

The Machin and Amendola References

The Machin paper presents kinetic data on the rate of hydrogen production when water vapor is reacted with purified samples of crystalline lithium hydride. The lithium hydride crystals are initially cooled or heated, as necessary, and maintained at selected temperatures of 0°C, 48.4°C, 70°C, 93.8°C, and 121°C. They are then exposed to a quantity of water vapor. But Machin doesn't add water vapor to heat the lithium hydride crystals and promote a reaction. He sets the initial temperature of his lithium hydride crystals and measures the kinetics of the reactions with water at his predetermined temperatures.

Machin et al describe the results of their experiments as follows. "The results are consistent with a rapid sorption of water vapor and reaction of the sorbate with the hydride, and the reaction is unusual in that the solid reaction product may be, almost exclusively, lithium oxide or hydroxide, depending solely on whether the amount of water introduced is sufficient to react with one surface layer (or less) of hydride, or with several layers."

Machin does not teach or suggest preparing a mixture of a hydride and hydroxide particles for release of hydrogen on demand.

Machin does not teach or suggest preparing a mixture of a hydride and hydroxide particles for release of hydrogen on demand and placing the mixture in a hydrogen storage device adapted for release of hydrogen from the device and delivery of the hydrogen to a hydrogen consuming application.

Machin does not teach or suggest a method of reacting a first portion of the hydride particles in the prepared mixture with water to produce heat in an amount to initiate reaction between a second portion of hydride with particles of hydroxide to produce hydrogen by such hydride-hydroxide reaction for a hydrogen consuming application. Applicants' claimed methods do not call for heating of the prepared mixture. The claims simply call for reaction with water.

Machin performs water-adding experiments to lithium hydride heated to several temperatures up to 93.8°C and 121°C, but teaches that the hydride/hydroxide reaction (Equation 22), occurs only at temperatures greater than 120°C. In fact, Machin states with respect to the reaction between hydride and hydroxide (Equation 22), "... but we have proved that this contribution is negligible over the range of temperatures used here." Certainly the Machin disclosure cannot be read to anticipate or suggest applicants' method of adding water to a mixture of hydride and hydroxide particles to promote a reaction between them. Machin actually teaches away from applicants' claimed methods.

Machin does not teach or suggest the preparation and storage of such a mixture of hydride and hydroxide particles so that the total amount of hydride particles reacts substantially completely with the water and particles of hydroxide to form hydrogen and an oxide.

Clearly, Machin does not teach or suggest preparing such mixtures of hydride and hydroxide particles which can be stored for release of hydrogen on demand, activated for release of hydrogen by an addition of water, and substantially fully reacted to release their hydrogen content and leave only a residue of oxide. The Machin reference does not anticipate, or make obvious, the methods of claims 1, 3-5, 7, 8, 10-12, 14, 19-21, 26-29, 54-55, 57, 63, and 67-70. Each of these rejections should be withdrawn and these claims should be allowed.

Applicants' claims 15, 48, 49, 61, and 64-66 are dependent claims in which the hydride particles comprise lithium borohydride. These dependent claims are rejected on a

combination of Machin with the Amendola et al published application. But the Amendola disclosure is unrelated to both the Machin disclosure and applicants' claimed methods. Each of the above differences between applicants' independent claims and Machin is applicable in distinguishing combinations of the Machin and Amendola disclosures from applicants' claimed methods. The rejections of claims 15, 48, 49, 61, and 64-66 should also be reconsidered and withdrawn.

The Examiner's patience in the prosecution of this application is appreciated. It is respectfully submitted that each of applicants' remaining claims 1, 3-5, 7, 8, 10-12, 14, 15, 19-21, 26-29, 48, 49, 54-55, 57, 61, 63-70 should be allowed and this application passed to issue.

If the Examiner feels that there are any remaining issues that could be resolved in a telephone conversation, he is invited to call applicants' attorney at a direct dial number: 248 786-0169.

Respectfully Submitted,

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